



# Beach Monitoring

## Current Methods and Limitations

**Richard Whitman**

**Lake Michigan Ecological Research Station**

**Great Lakes Science Center**

# Basic Monitoring Objectives

- **Protect human health**
- **Detect and characterize pollution**
- **Provide information for remediation**

# Criteria For Quality Indicator

- **Relevance to health effects**
- **Source characterization**
- **Timely results**
- **Data confidence**
- **Beach specificity**
- **Economy, ease, effectiveness**

# Beach Sampling Approach

- Test for *E. coli* or fecal coliform
- Samples generally taken
  - Morning
  - At shore or knee deep
  - From the surface
- Monthly, weekly, or daily
- Single sample per beach



# Important Criteria

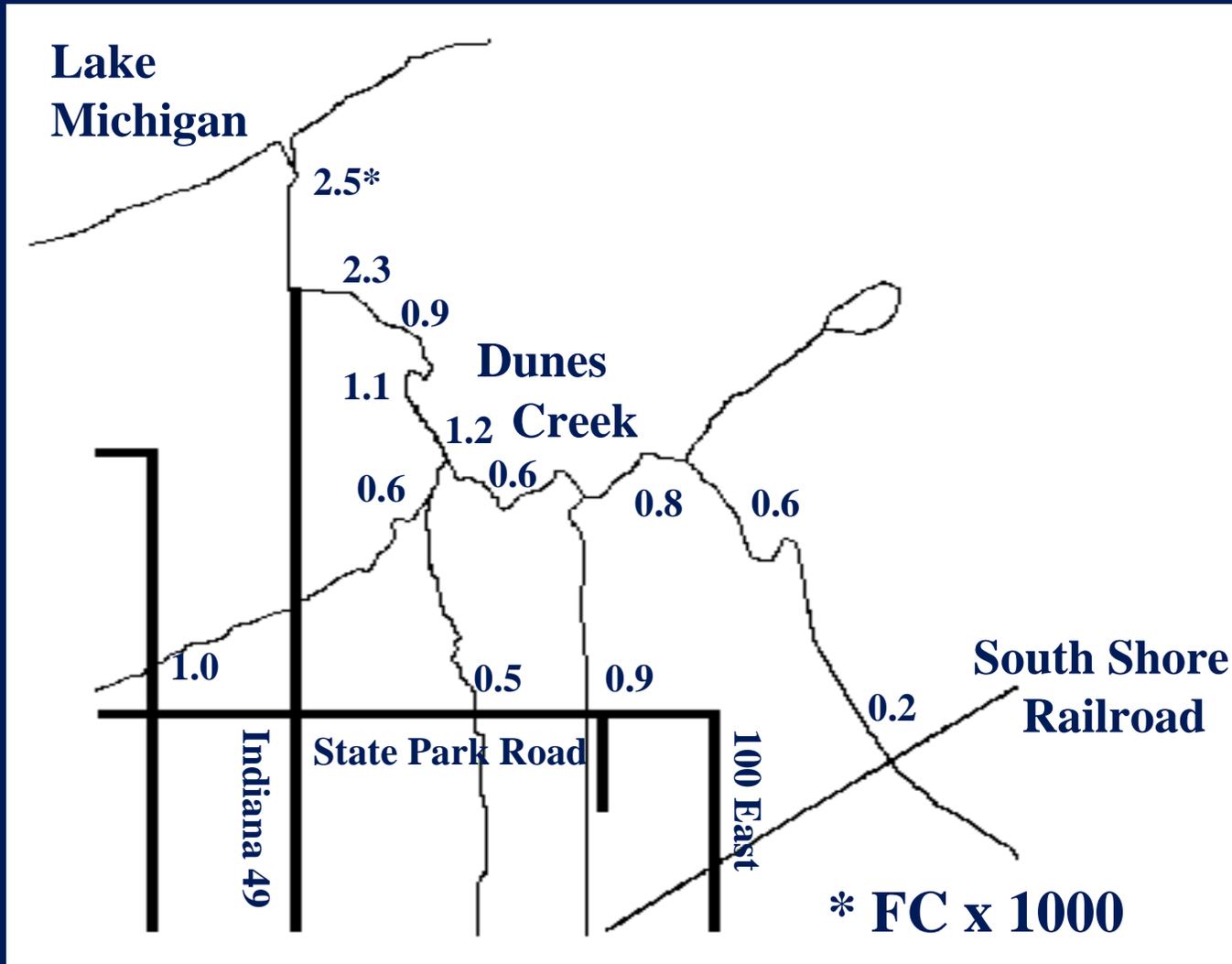
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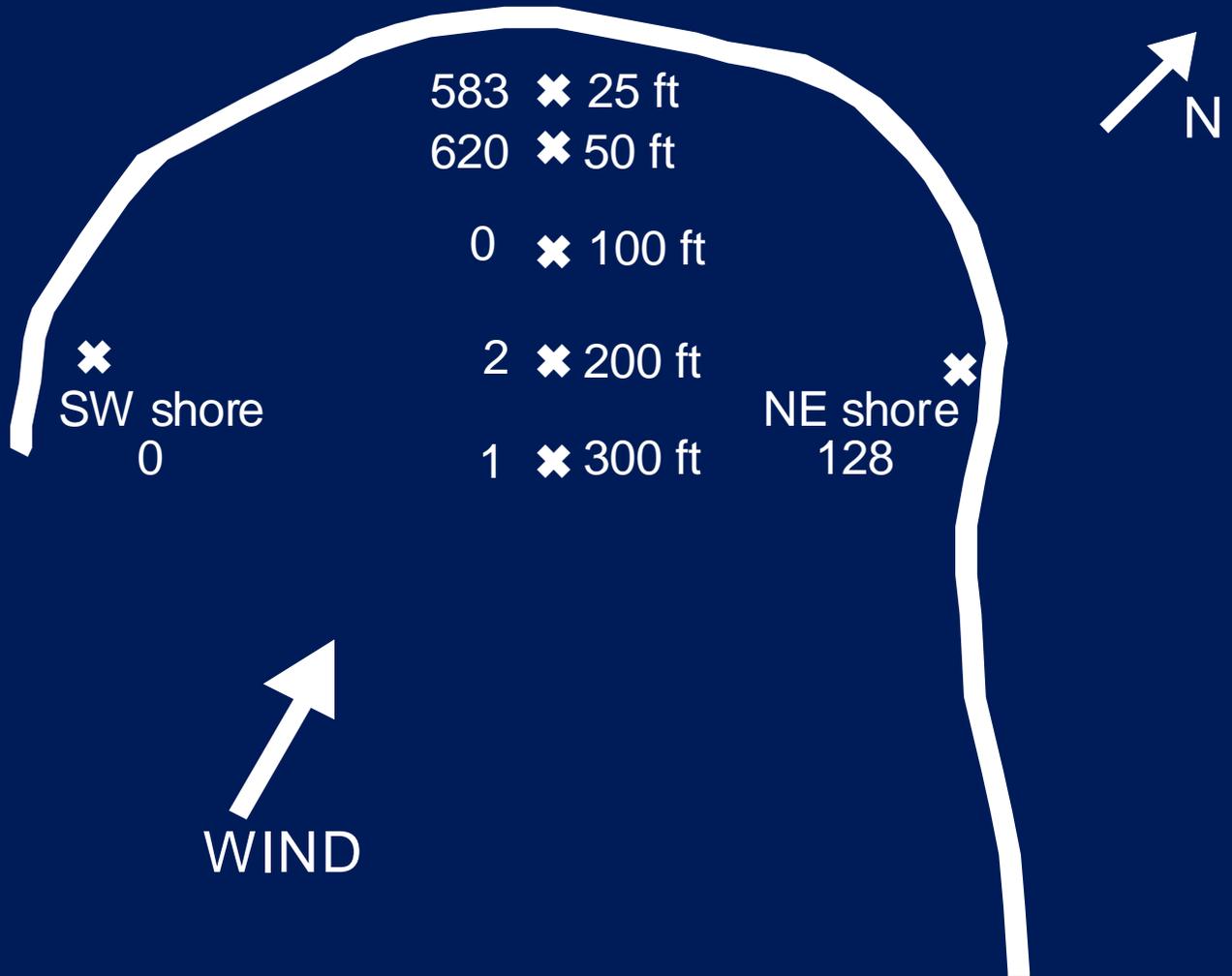
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# Dunes Creek Sampling Stations

Mean fecal coliform concentrations (colonies x 1000)



# Little Glen Lake, Sleeping Bear Dunes National Lakeshore (*E. coli* counts in CFU/100 ml)



# Correlations among Seagull numbers and *E. coli* concentrations

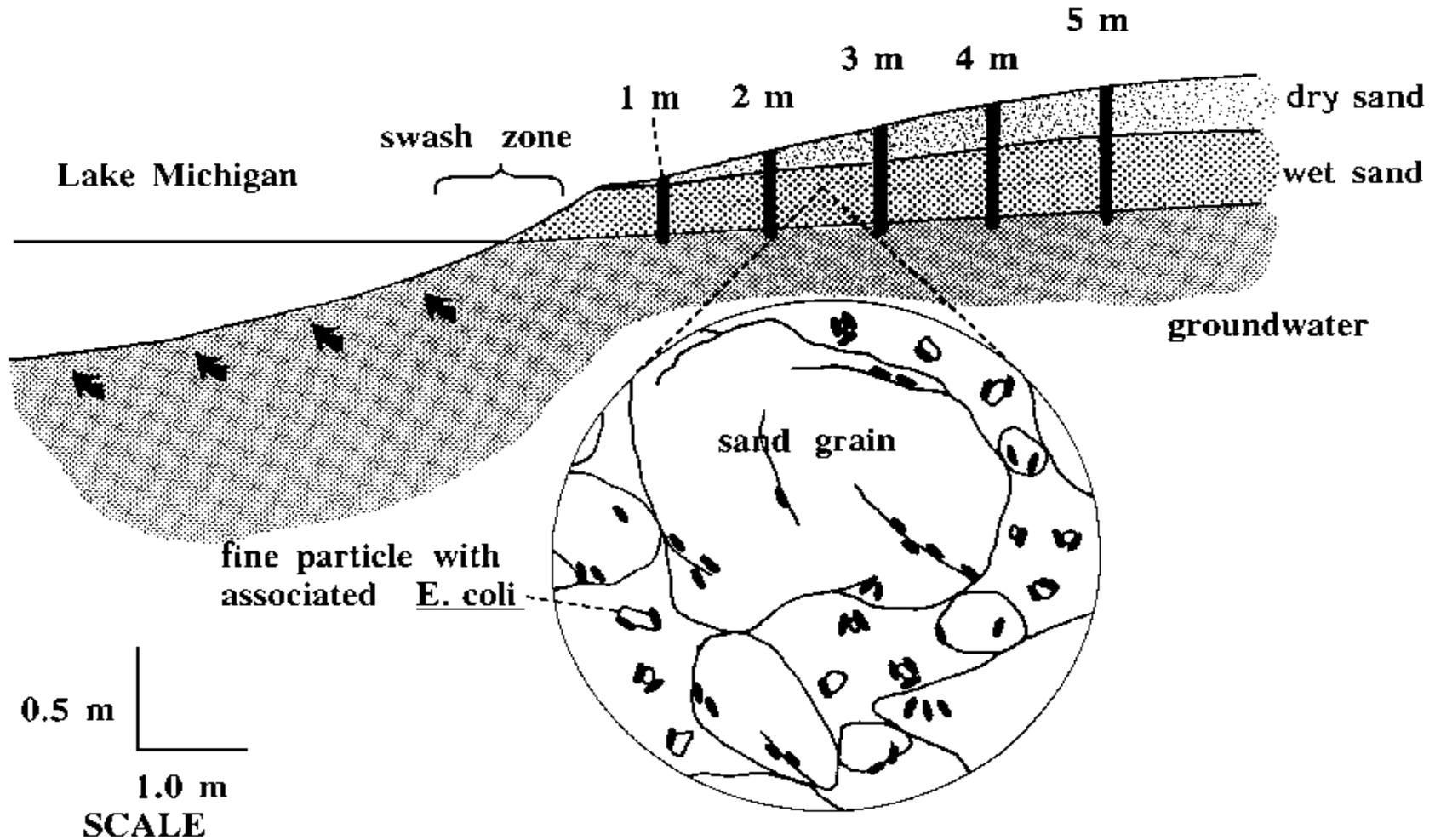
63<sup>rd</sup> St. Beach, Chicago, Summer 2000

	# gulls unlagged, P values	# gulls lagged 1 day, P values
Foreshore sand	0.133	0.000*
Submerged sand	0.972	0.046
45 cm water AM	0.224	0.004*
90 cm water AM	0.037	0.001*
45 cm water PM	0.916	0.167
90 cm water PM	0.432	0.008

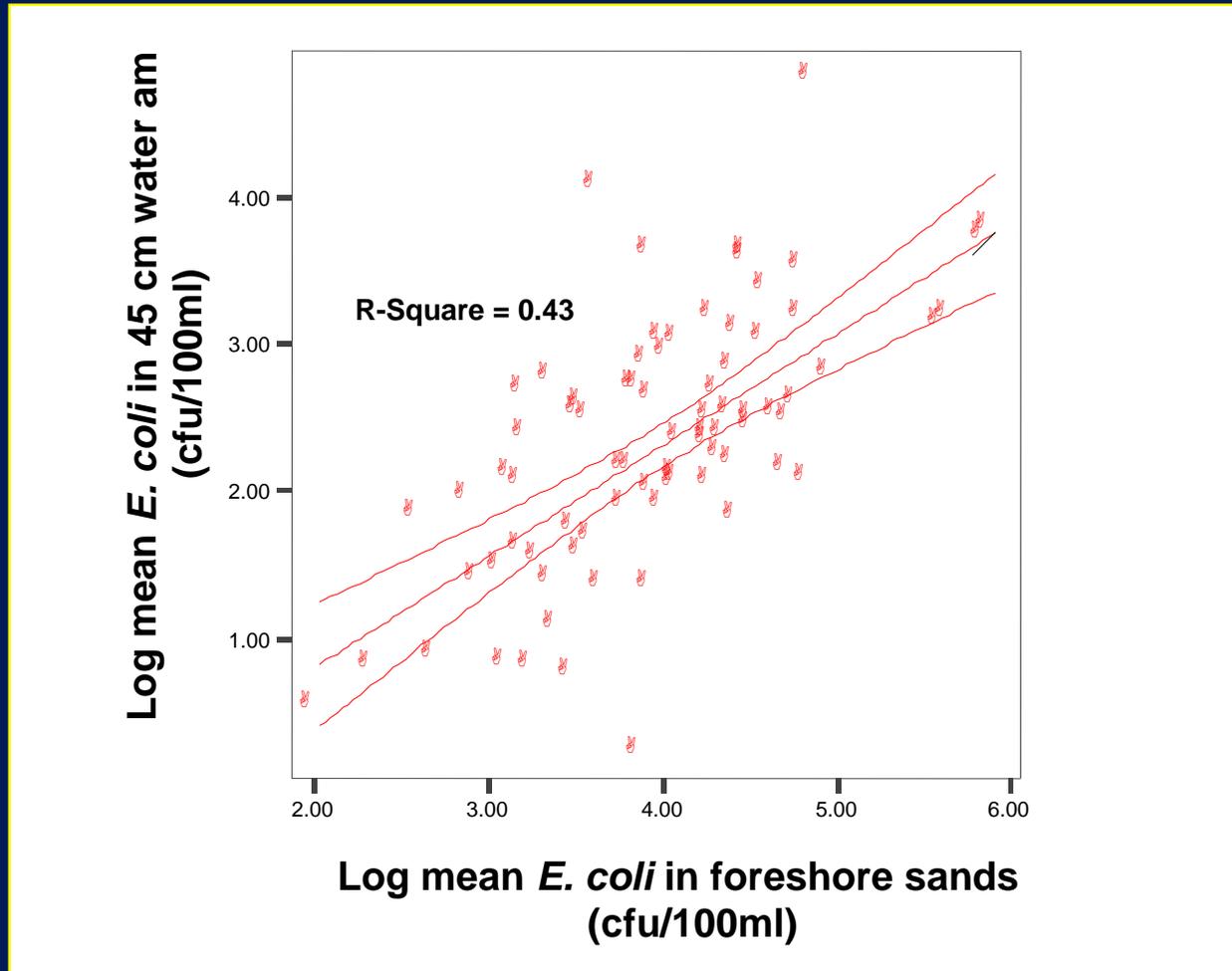
Two-tailed significance of correlations

Critical p value Bonferroni corrected =0.006

# *E. coli* in Sand



# Linear regression of *E. coli* concentrations in sand and water 63<sup>rd</sup> St. Beach, Chicago, Summer, 2000



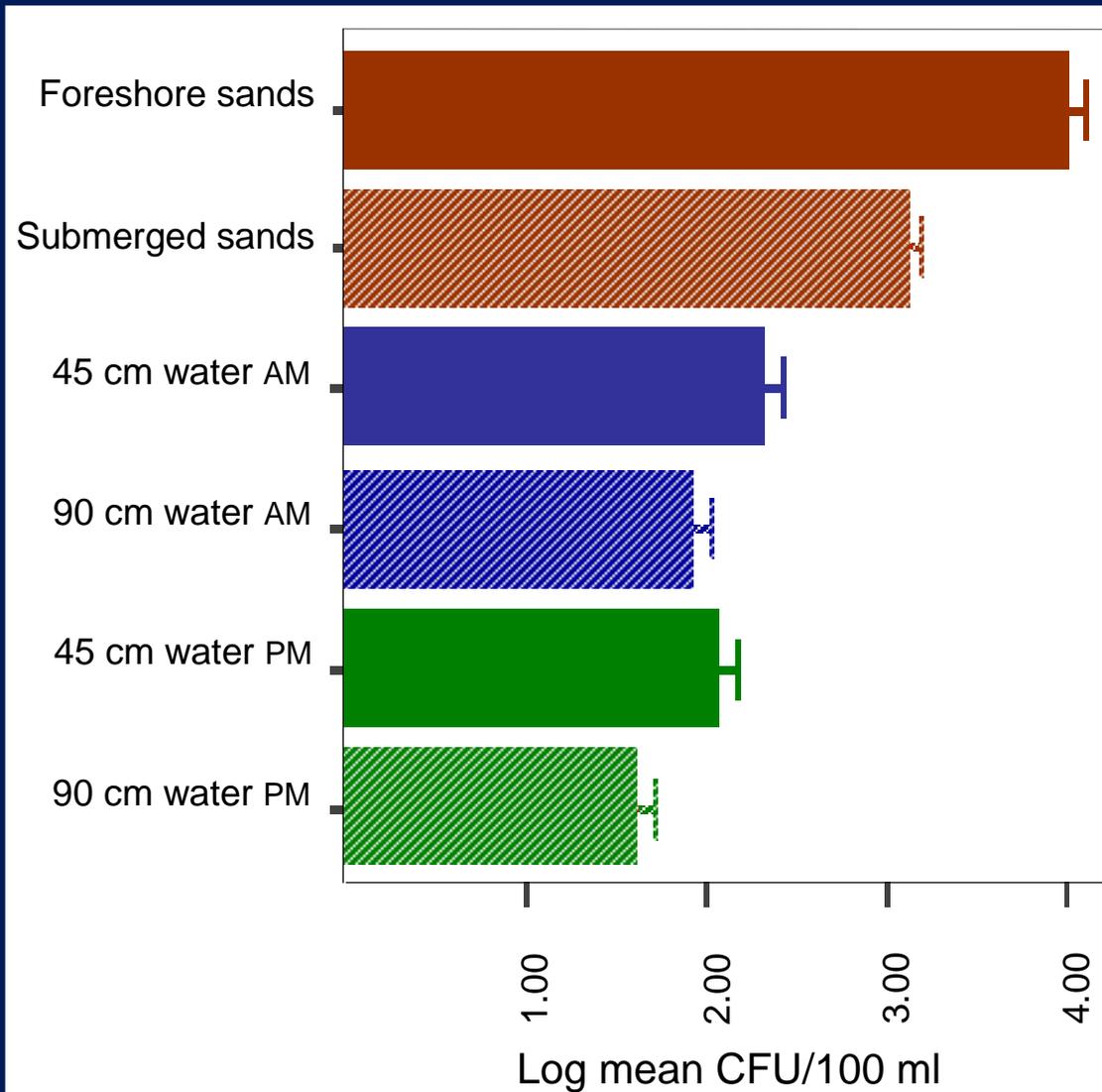
# Water and Sediment *E. coli*

## 63<sup>rd</sup> St. Beach, Summer, 2000

		Sub	Fore	90 am	45 am	90 pm	45 pm
Sub	R	1.000					
	P						
Fore	R	0.395	1.000				
	P	0.000					
90 cm am	R	0.363	0.317	1.000			
	P	0.000	0.000				
45 cm am	R	0.431	0.482	0.793	1.000		
	P	0.000	0.000	0.000			
90 cm pm	R	0.339	0.400	0.716	0.620	1.000	
	P	0.000	0.000	0.000	0.000		
45 cm pm	R	0.328	0.317	0.534	0.595	0.687	1.000
	P	0.000	0.000	0.000	0.000	0.000	

R = Spearman correlation coefficient

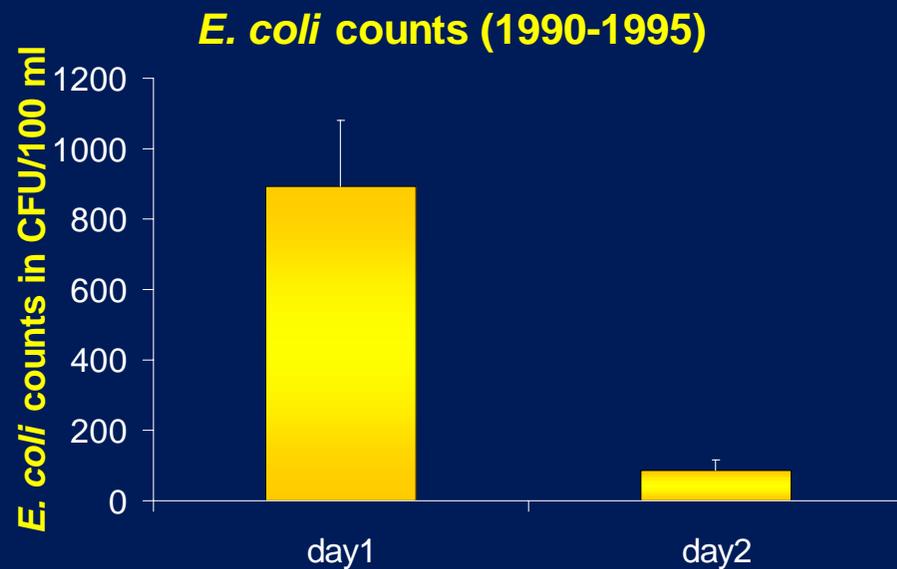
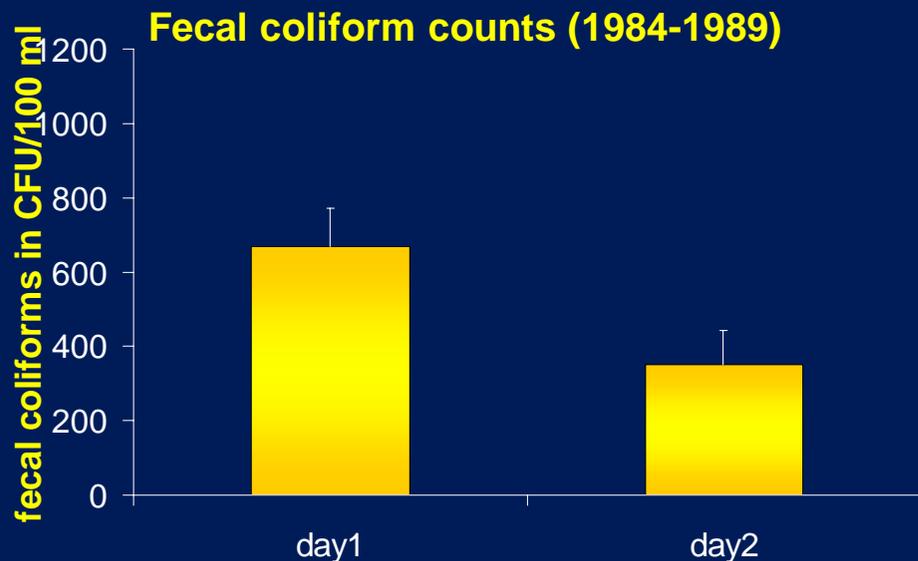
P = two-tailed significance



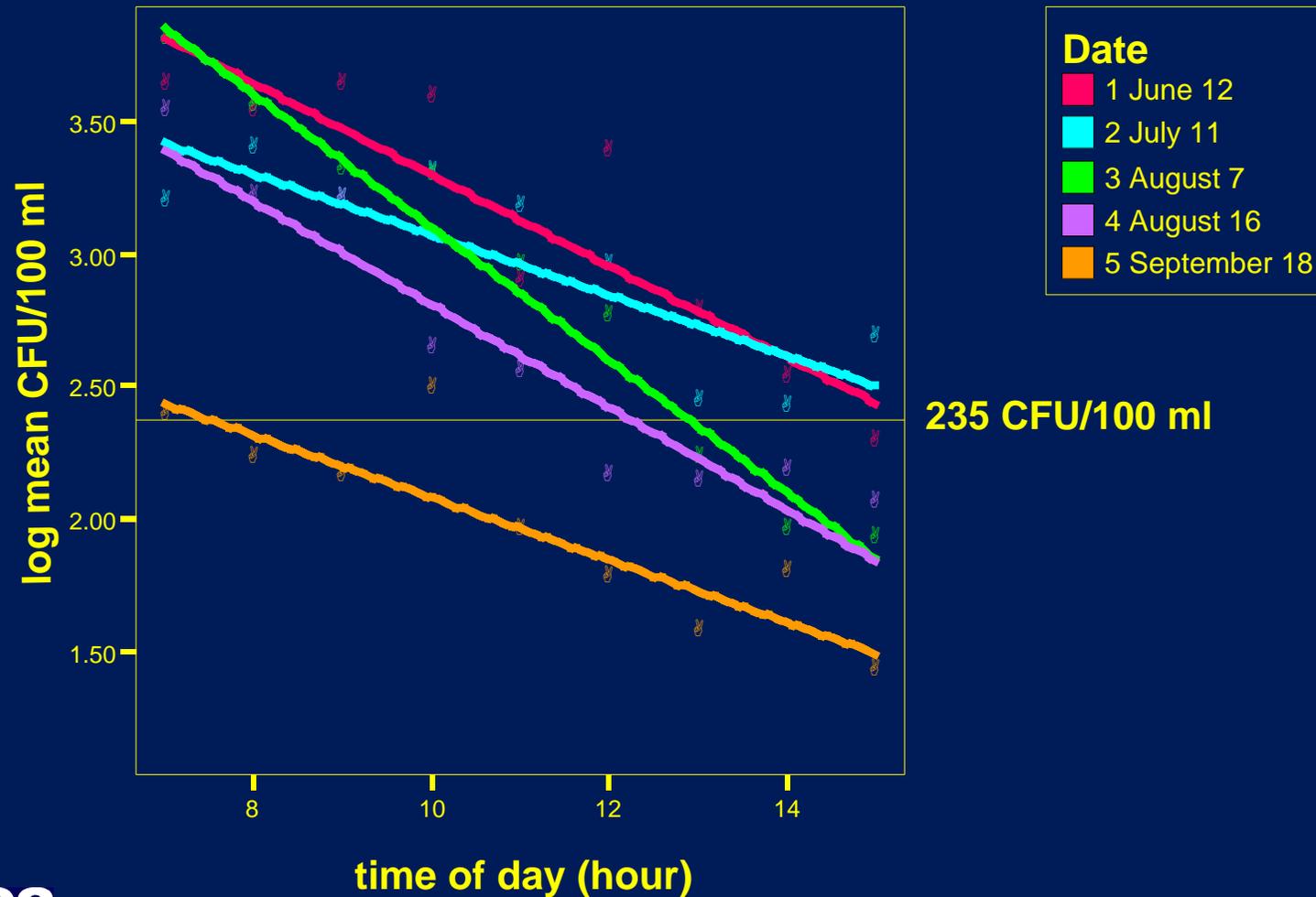
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# Next day differences in fecal coliform and *E. coli* counts, Indiana Dunes



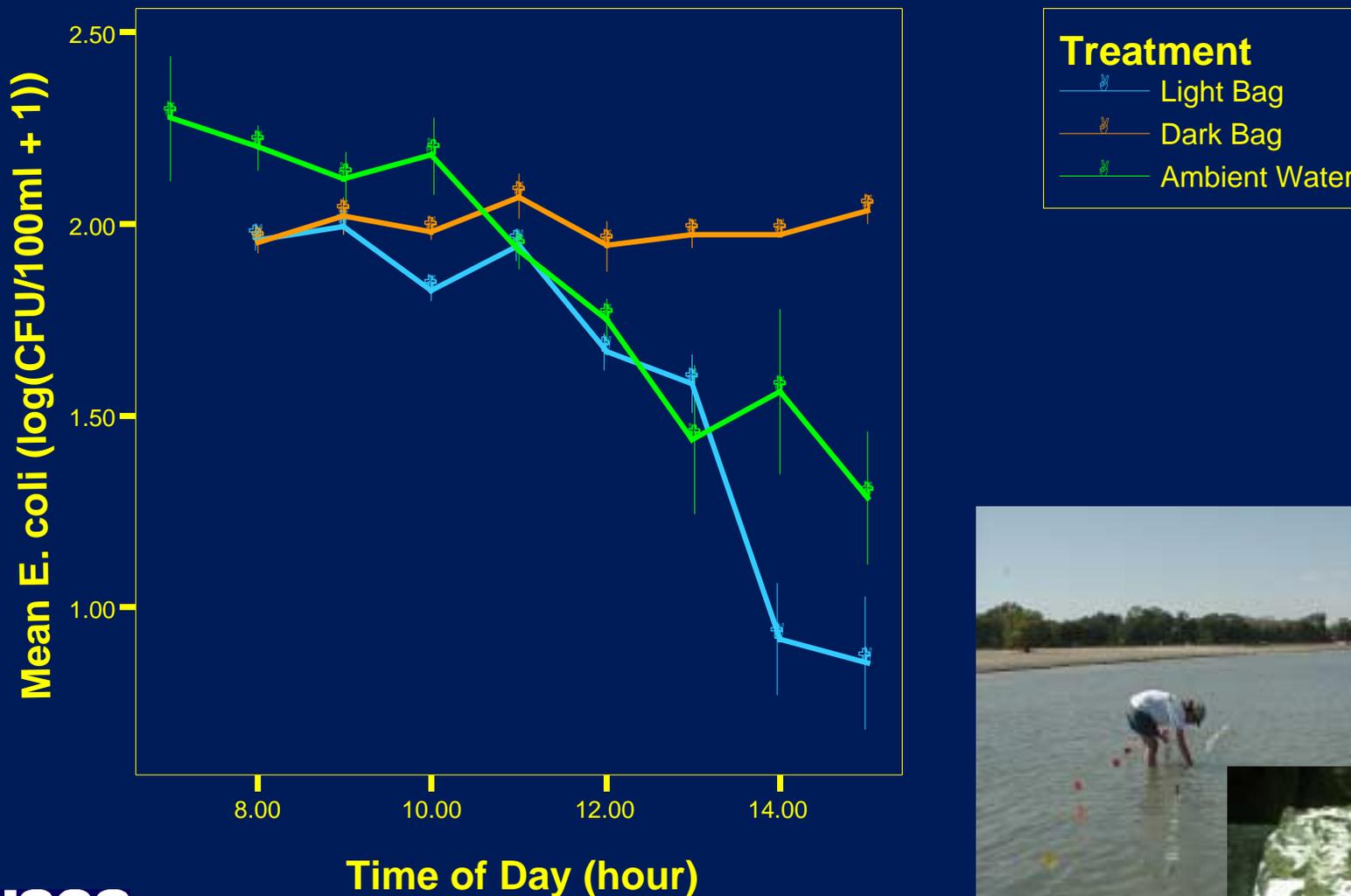
# Hourly *E. coli* Concentrations 63<sup>rd</sup> St. Beach, Chicago, 2000



# Results of Light/Dark Bag Experiment

63<sup>rd</sup> St. Beach, Chicago

September 18, 2000



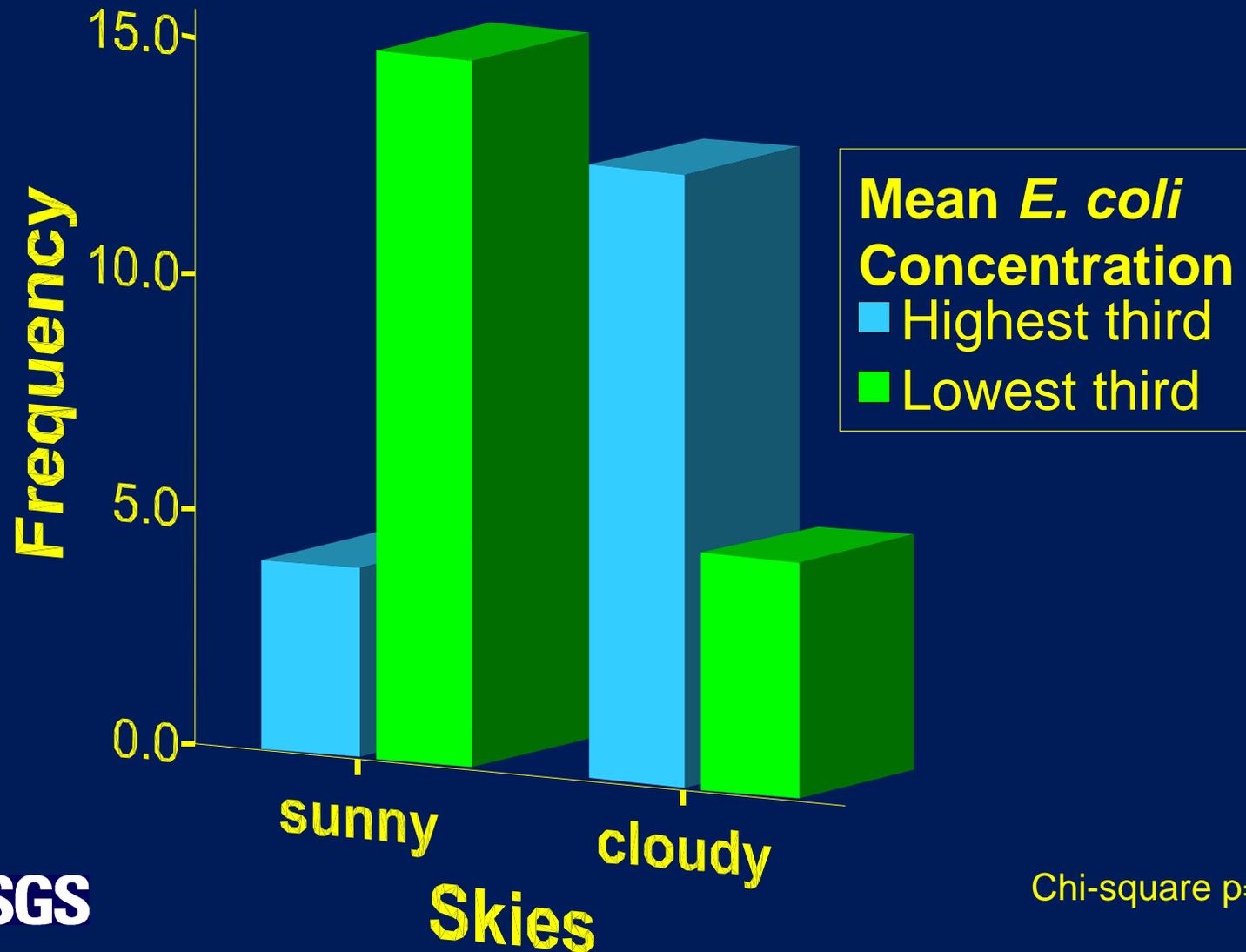
**Treatment**

- Light Bag
- Dark Bag
- Ambient Water



# *E. coli* Concentration and Cloud Cover

63<sup>rd</sup> St. Beach, Chicago, Summer, 2000



Chi-square  $p=0.016$

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# Estimated Sample Sizes Required to Achieve 95% Confidence Limits $\pm d\%$ of the Mean

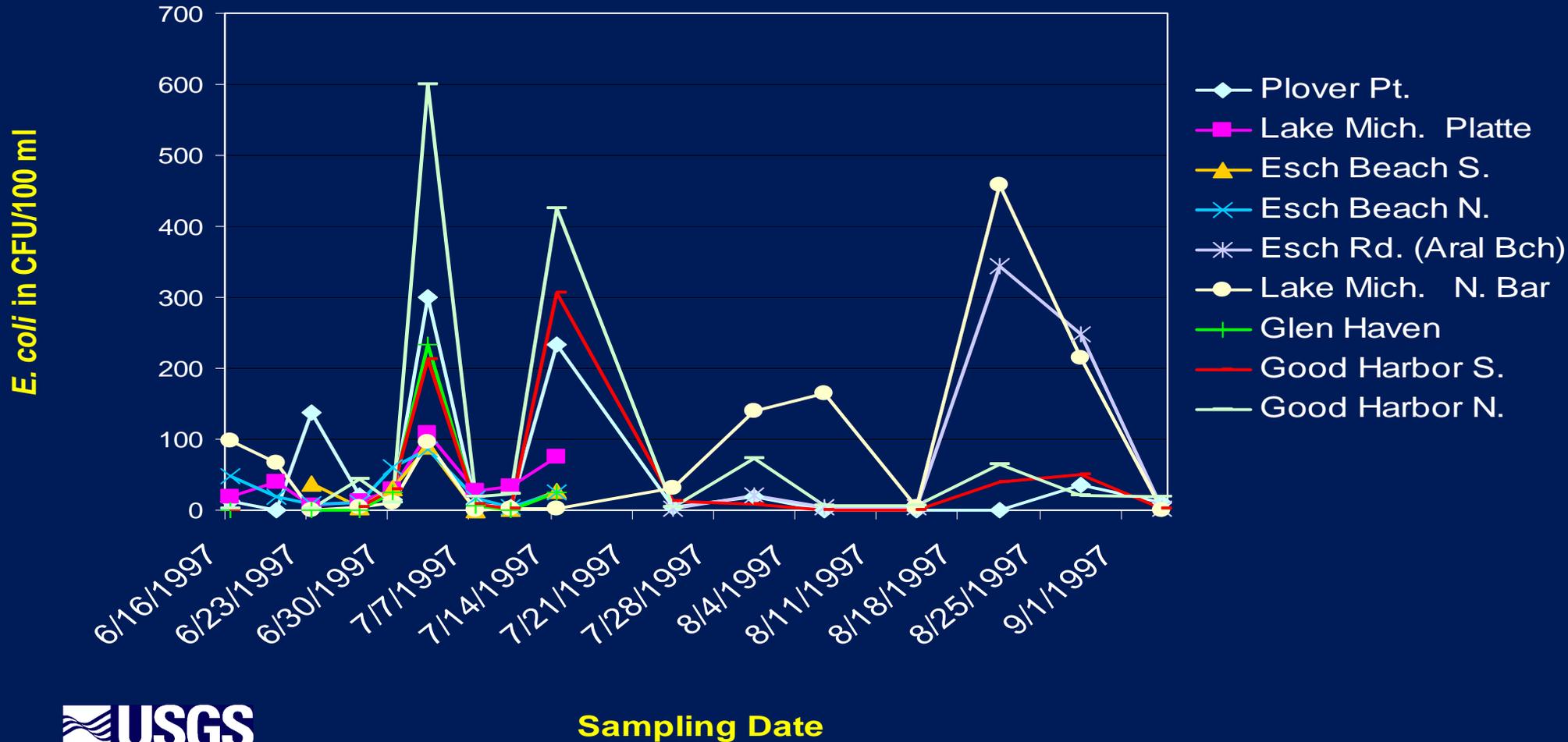
63<sup>rd</sup> St. Beach, Chicago, Summer, 2000

Date	$d = 20\%$	$d = 30\%$	$d = 40\%$
5/18	526	234	132
6/1	103	46	26
6/6	18	8	5
6/21	17	8	5
7/5	25	12	7
7/12	14	7	4
7/25	12	5	3
8/8	6	3	2
8/23	11	5	3
9/11	65	28	16

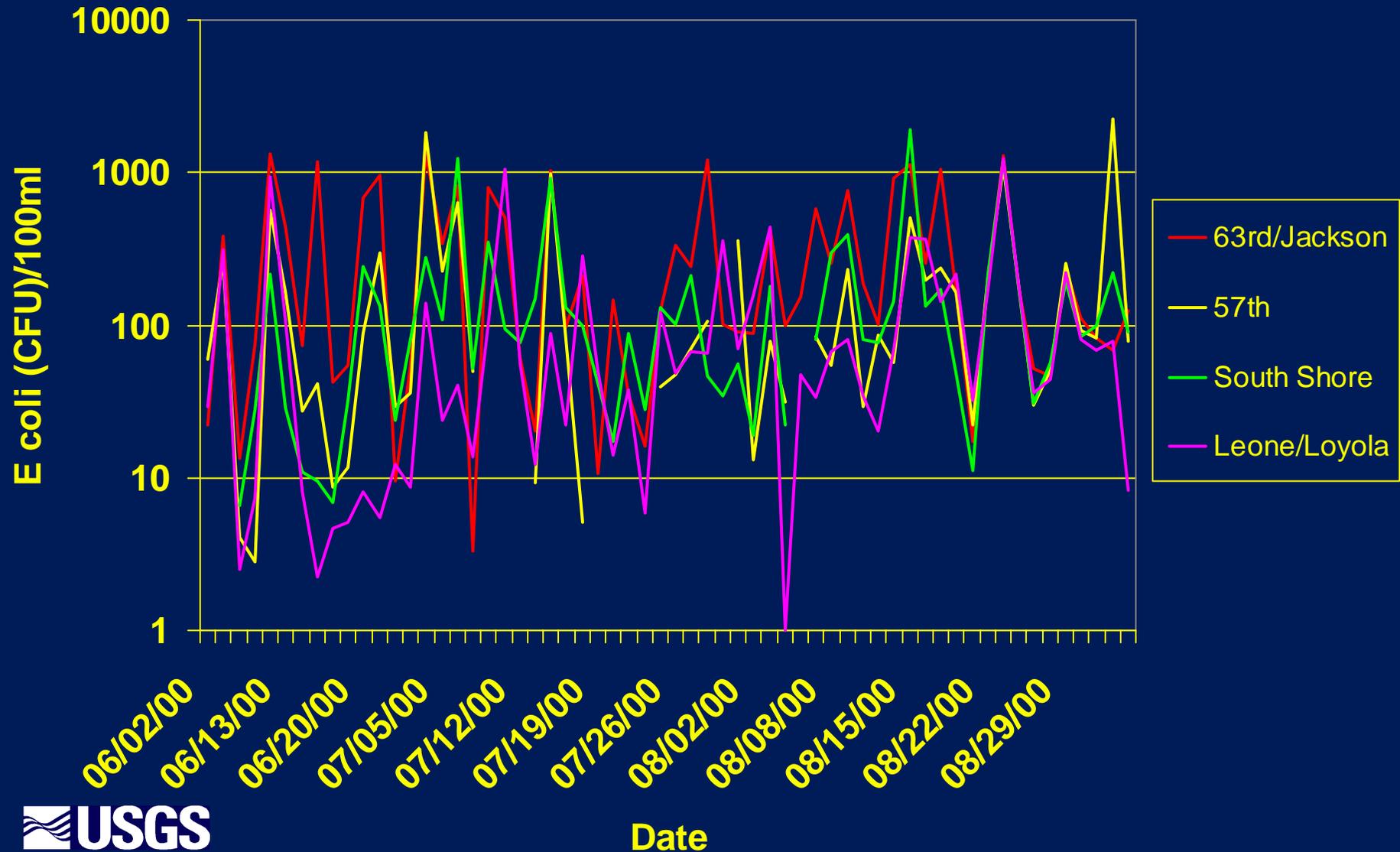
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# Summer 1997 *E. coli* concentrations, Sleeping Bear Dunes National Lakeshore, Lake Michigan

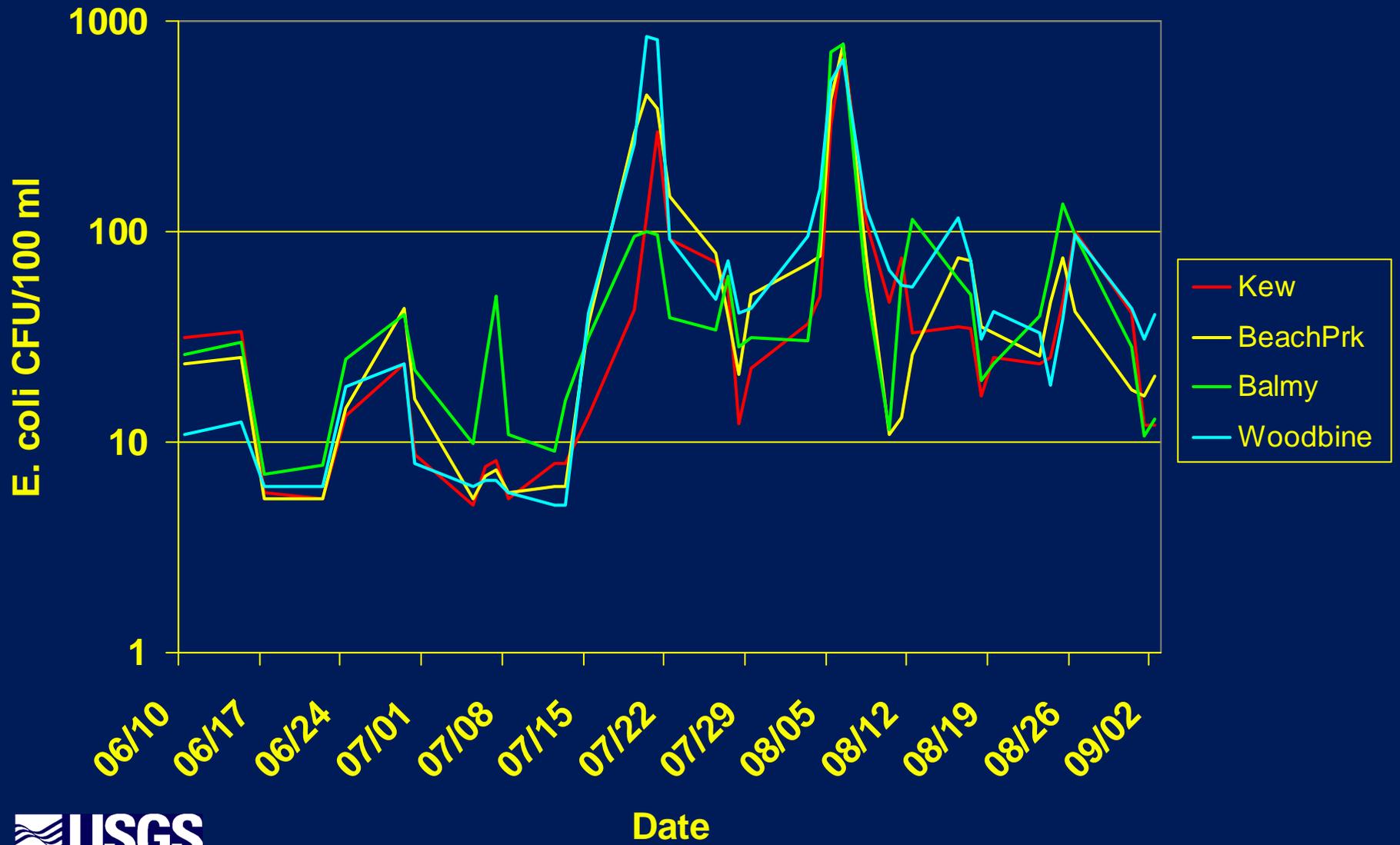


# Summer 2000 *E. coli* Concentrations, Chicago Beaches, Lake Michigan



All beaches correlated at  $P < 0.001$

# Summer 1999 *E. coli* Concentrations, Toronto Beaches, Lake Ontario



# General Forces

- **Currents**
- **Sediments**
- **Orientation**
- **Weather**
- **Runoff**

# Local Forces

- **Morphology**
- **Shoreline Orientation & Exposure**
- **Sources**
  - **Direct (e.g. sewage, birds)**
  - **Indirect (e.g. sands, rivers, submerged storage)**

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# Clearly Economical and Easy

- **Effective- Site & situation specific**
  - **Good for trends & characterization**
  - **Point sources and chronic problems**
  - **Historical data base development**

# **Richard Whitman**

**Lake Michigan Ecological Research Station  
Great Lakes Science Center  
Porter, IN**

**Phone: (219) 926-8336 ext. 424**

**Fax: (219) 929-5792**

**Email: [richard\\_whitman@usgs.gov](mailto:richard_whitman@usgs.gov)**